

## The paramedic ambulance: a Canadian experience

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Prehospital critical care provided by specially trained ambulance attendants in New Westminster, BC during a 27-month period was studied. Although the most important benefit of the improved care was the prevention of sudden death in a large proportion of persons with crises due to coronary artery disease, the skills learned to provide basic life support are applicable to a wide variety of other disorders that can result in death before the patient reaches hospital.

A New Westminster, BC on a étudié durant une période de 27 mois les soins d'urgence prodigués juste avant l'hospitalisation par des ambulanciers ayant reçu une formation spéciale. Bien que le plus important avantage relié à l'amélioration des soins ait été la prévention des morts subites qui surviennent chez un grand nombre de personnes au cours d'une crise due à une maladie coronarienne, les connaissances acquises pour pouvoir assurer un soutien vital sont applicables à une multitude d'affections qui, toutes, peuvent entraîner la mort avant que le patient ait pu parvenir à l'hôpital.

The feasibility of training and employing ambulance attendants as "paramedics" in a Canadian urban setting was recently examined in a pilot

project conducted at the Royal Columbian Hospital. The principal objectives of this project were to gain information about the volume and variety of illnesses that might be affected by such a program, to study the degree of independence from physician control that could safely be permitted and to study the relation of a paramedic program to the existing institutions that provide emergency care.

### Methods

The Royal Columbian Hospital is a 420-bed acute-care facility 24 km from the centre of Vancouver, serving a community of approximately 250 000 people. It operates an active emergency department staffed with full-time emergency physicians, and acts as a regional referral centre for other hospitals in the Fraser Valley.

The paramedic program at this hospital began in 1972 as a volunteer effort, but protective legislation and funding gained in 1975 under the then newly formed Emergency Health Service Commission of British Columbia allowed expansion to its present format. The new training course offered a select group of experienced ambulance attendants more than 1000 hours of clinical teaching in all the critical-care areas of the hospital and required a full year to complete. The graduates of this course were referred to as EMA IIIs (emergency medical assistants, level III) to indicate that they had achieved the third and highest level of training and competence in the provincial ambulance system.

The EMA III designation indicated the ability to apply the following "special procedures", each usually beyond the scope of ambulance attendants and designed to provide advanced life support in critical situations:

- Establishment of an intravenous route.
- Direct-current defibrillation.
- Airway control, including endotracheal intubation and positive pressure ventilation.
- Cardiac monitoring, including recognition and treatment of arrhythmias.

● Intravenous or intracardiac administration of selected drugs, either with physician's orders or without orders when part of an established protocol. Special protocols were established to permit the regulated use of lidocaine, atropine, sodium bicarbonate, and epinephrine and calcium (in cardiac arrest) without the necessity of prior physician's approval. Other drugs could be administered, but only after approval had been received from a physician, either by telephone or by a radio link through central dispatch. When necessary the physician could request transmission of an electrocardiographic monitor pattern to the emergency department from the scene.

Special procedures were performed without prior contact with a physician when the paramedic judged that a delay in treatment might result in serious illness or death. From a practical standpoint the special procedures were indicated in cases of suspected acute myocardial infarction,

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acute respiratory failure from any cause, unconsciousness with an unprotected airway, shock or cardiopulmonary arrest.

All persons who were not in such immediate danger were transported to hospital in the usual manner without special procedures, and consequently have been excluded from consideration in this study.

From the outset two categories of critically ill persons required the application of special procedures. All who maintained a spontaneous heartbeat but required special procedures were designated SPC to indicate their having received special preadmission care, and all who experienced cardiac arrest (defined for the purposes of this study as the absence of cardiac contractions in an unconscious individual) some time prior to arrival at the hospital were designated CA.

Below are presented the results of 24-hour EMA III coverage in the New Westminster area during the 27-month period from April 1975 through June 1977. Initially only one vehicle was in service, but as of

November 1976 there were two vehicles.

## Results

Of the 6968 persons attended by an EMA III crew during the study period 851 (12.2%) required special procedures. Of the 624 SPC patients 426 (68.3%) (Table I) were considered to have a primary cardiac problem as judged by a retrospective review of ambulance and hospital records. The other 198 (31.7%) had a variety of other primary disorders, all requiring some form of respiratory or cardiovascular support during transport; the distribution of these disorders was fairly even.

### Cardiac disease

The consequences of coronary artery disease accounted for the highest proportions of patients transported — 68.3% of SPC patients and 90.3% of CA patients (Table I).

A detailed analysis of the cases of cardiac disease in SPC patients is found in Table II. The patients pre-

sented with either suspected acute myocardial infarction or one of the complications of coronary artery disease such as syncope, pulmonary edema or shock. All patients with suspected myocardial infarction were included in the table, although some were subsequently found not to have cardiac disease; this approach was adopted because it was consistent with the accepted practice of initiat-

Table I—Distribution of disorders in 851 patients requiring "special procedures" (see text) during transport in an EMA III ambulance

Disorder	No. (and %) of patients*		
	SPC	CA	Total
Cardiac disease	426 (68.3)	205 (90.3)	631 (74.1)
Respiratory disease	38 (6.1)	1 (0.4)	39 (4.6)
Traumatic injury	30 (4.8)	8 (3.5)	38 (4.5)
Hypoglycemic coma	37 (5.9)	0 (0)	37 (4.3)
Drug overdose	31 (5.0)	5 (2.2)	36 (4.2)
Miscellaneous	62 (9.9)	8 (3.5)	70 (8.2)
Total	624 (100.0)	227 (99.9)	851 (99.9)

\*SPC refers to patients requiring special preadmission care other than for cardiac arrest (CA).

Table II—Details of the 426 cases of suspected cardiac disease in SPC patients

Detail	Frequency
Presenting complaint	No. (and %) of patients
Chest pain	
Alone	188 (44.1)
With other symptoms	121 (28.4)
Total	309 (72.5)
Other	
Shortness of breath	177 (41.5)
Syncope	46 (10.8)
Medication given intravenously	No. of occasions*
Morphine	125
Lidocaine	66
Furosemide	62
Atropine	20
Aminophylline	12
Bicarbonate	4
Life-threatening complications	Total no. of patients (and no. improved)
Malignant ventricular ectopic beats	66 (54)
Shock due to bradycardia	20 (16)
Cardiogenic shock	17 (2)
Complete heart block	5 (1)
Pulmonary edema requiring intubation and ventilation	3 (3)

\*In a total of 202 patients.



Courtesy of Bill Elford, audiovisual department, Ottawa Civic Hospital

**Specially trained ambulance attendants can provide advanced life support in critical situations**

Table III—Details of the 227 cases of cardiac arrest

Detail	Frequency
	Total no. of patients (and no. resuscitated)
When arrest occurred	
Before EMA III attendant arrived	211 (49)
During attendance	16 (9)
Total	227 (58)
Primary cause of arrest	
Coronary artery disease	205 (52)
Trauma	8 (0)
Drug overdose	5 (2)
Status asthmaticus	1 (1)
Drowning	1 (1)
Other	7 (2)
Presenting arrhythmia	
Ventricular fibrillation	116 (38)
Asystole	85 (13)
Heart block or idioventricular rhythm	26 (7)
Special procedure(s) used	
Defibrillation and IV administration of drugs	202 (44)
IV administration of drugs alone	23 (12)
Defibrillation alone	2 (2)
Endotracheal intubation	198 (48)
Intracardiac injection	54 (4)
Response to resuscitative measures	No. (and % of all with arrest)
None	128 (56.4)
Temporary	41 (18.1)
Full	58 (25.6)

Table IV—Details of the 58 cases of cardiac arrest in which resuscitative measures were successful\*

Detail	Total no. of patients (and no. discharged)
Primary cause of arrest	
Coronary artery disease	52 (19)
Trauma	0 (0)
Drug overdose	2 (0)
Status asthmaticus	1 (1)
Drowning	1 (1)
Other	2 (0)
Presenting arrhythmia	
Ventricular fibrillation	38 (15)
Asystole	13 (3)
Heart block or idioventricular rhythm	7 (3)
Outcome	
Died in emergency department	10
Died in hospital after	
0-48 hours	9
2-7 days	8
> 7 days	10
Discharged alive	21

\*Mean age of the patients was 60.7 years.

ing treatment in patients suspected on clinical grounds of having had an acute myocardial infarction.<sup>1</sup>

Chest pain, alone or in combination with shortness of breath and syncope, was the presenting symptom in 72.5% of this group of patients. Shortness of breath and syncope were present in 41.5% and 10.8% of these patients respectively.

The early treatment of dangerous arrhythmias is a well recognized component of modern coronary care.<sup>2,3</sup> During this study malignant ectopic ventricular beats associated with suspected myocardial infarction were eliminated by treatment with lidocaine in 54 of the 66 instances, and shock related to bradycardia was reversed with atropine administration in 16 of the 20 instances.

The other benefits of medication administered intravenously were less easy to document, but included the early relief of chest pain with morphine, furosemide and aminophylline, alone or in combination.

In three patients presenting with pulmonary edema and respiratory arrest, stabilization was achieved by early endotracheal intubation, and they survived to hospital discharge.

#### Cardiac arrest

All those found without a cardiac beat and with a history suggesting recent collapse were considered to have suffered cardiac arrest. The EMA III attendants were forbidden

to assess salvageability, which might ordinarily have been considered poor in the presence of irreversible disease, a long interval prior to the start of resuscitative measures or advanced age. Once begun, resuscitative measures were discontinued only on the order of a physician. Resuscitation, defined for the purposes of this study as the restoration of spontaneous cardiac rhythm and pulse by the time of arrival at the emergency department, was achieved in 58 of the 227 CA patients (Table III); of the 58, 10 died in the emergency department, 27 died in the hospital and 21 survived to discharge (Table IV). Follow-up information on the patients discharged was not available.

Approximately one half of the CA patients were found in ventricular fibrillation and about a third in asystole, an observation consistent with reports from other groups.<sup>4,5</sup> Of the 13 patients resuscitated from asystole 3 survived to discharge (Table IV); to our knowledge such success with asystole has not been reported by other groups. Most other programs seem to have concentrated their resuscitative efforts on patients with ventricular fibrillation, and to have assumed irreversibility of cardiac standstill.<sup>4,6,7</sup>

#### Noncardiac illness

The remaining 31.7% and 9.7% of SPC and CA patients respectively had disorders other than cardiac.

Thirty-eight cases of respiratory disease necessitating SPC (Table I) were encountered; three patients required intubation and assisted ventilation. Cardiac arrest occurred in only one of these patients, a 16-year-old with asthma found in asystole. All survived to hospital discharge.

Only 38 patients with traumatic injury were transported (Table V), a much smaller number than had been expected, especially in view of the reputation of our hospital as a regional trauma centre. None of those with cardiac arrest could be resuscitated, which reinforced our early suspicions about the futility of resuscitative measures in this situation.<sup>8</sup> Although the SPC patients probably did benefit from airway stabilization and early intravenous therapy, the treatment of traumatic injury cannot be regarded as a major focus of this program.

Glucose was given intravenously

Table V—Details of the 38 cases of traumatic injury

Detail	No. of patients
No. transported	
SPC	30
CA	8*
SPC patients	
Condition when ambulance arrived at scene of accident	
Clinical shock	18
Unconscious	7
Respiratory arrest (endotracheal tube inserted)	4
Condition during transport	
Remained stable	18
Vital signs improved	9
Vital signs deteriorated	3
Outcome	
Died in emergency department	3
Died in hospital	4
Discharged alive	23

\*None could be resuscitated.

to 37 unconscious persons with hypoglycemia.

The number of cases of drug overdose (Table VI), 36, exceeded our expectations. Ventilatory assistance was required in 14 cases, including 10 of respiratory arrest. Two of the five patients with cardiac arrest were resuscitated but died in hospital.

The remaining 70 patients had a variety of disorders, including acute anaphylactic shock in 2; these 2 patients recovered after receiving epinephrine and fluids intravenously.

## Discussion

Many questions raised by this study cannot be answered by the data presented, and to attempt to deal with any of them in a comprehensive way would be beyond the scope of this paper. A more critical evaluation of EMA III care with controlled data will be reserved for a future presentation. The following discussion relates to the original objectives of the project, as presented at the beginning of this paper. It is intended as an introduction to the subject of prehospital care and as an indication of the direction in which more study is required.

### Volume and variety of caseload

Despite the hospital's urban location, only 851 (12.2%) of 6968 persons attended by the EMA III crew required the application of special procedures. Probably this was

due to a combination of lack of public awareness and poorly organized dispatching, both of which can be expected to be corrected gradually. Low volume, however, remains a serious concern that weighs against the establishment of similar programs in settings other than high population density, not only because of the cost but also because skills that are infrequently used will quickly be lost.

Cardiac disease, as expected, was the most important clinical problem, accounting for 74.1% of all cases requiring the application of special procedures and providing the main focus for the program. The skills learned for dealing with the ultimate emergency, cardiac arrest, are applicable to a wide variety of other disorders that can result in the patient's death before arrival at hospital. Although there is a tendency to widen the range of disorders handled in this kind of program, the benefits of such widening must be carefully weighed against the loss of specialization and deterioration of care that might result.

### Independence from physician control

Although close direction by physicians was initially attempted by radio, it soon became clear that greater independence was necessary. Not only did transmission of electrocardiographic monitor patterns prove to be time-consuming, but also the recognition of arrhythmias formed only a small part of the decision-making at the scene. Furthermore, the ability of the attendants to recognize arrhythmias improved quickly to the point where it far exceeded the reliability of the transmitting equipment. The physicians soon discovered that the attendants were providing them with accurate and relevant information.

It was decided that quality control had to be maintained by strict adherence to protocols and by case review when the patient arrived in the emergency department. This depended greatly on the rapport between physicians and EMA III attendants developed during the training program.

### Relation to existing institutions

Despite initial apprehension the EMA III program gained support from both physicians and nurses, largely as a result of the extensive interaction during the in-hospital training period. A crew prepared to

provide 24-hour service was easily trained in a year, at relatively little cost, with the use of hospital facilities. Disruption of hospital services was minimized because a clinical instructor accompanied the trainees during their hospital work in patient-care areas.

Thus far there have been no serious complications from the use of complex procedures by paramedical individuals. The use of a paramedic team as an extended arm of the emergency department enhances the reach of that facility without sacrificing the usual control systems.

## Conclusions

The data presented show that advanced prehospital care can be successfully applied by specially trained ambulance attendants in a Canadian urban setting. Although the full significance of such a program cannot be assessed on the basis of these data, it seems that, at the very least, sudden death from cardiac disease can be prevented in a considerable proportion of instances.<sup>9-11</sup> In addition, early assistance of ventilation and circulation may prevent deterioration in a variety of other disorders.

Perhaps the most significant aspect of this venture has been the insight gained into the prehospital phase of illness, an aspect of the disease process that until recently has attracted little attention from the Canadian medical profession.<sup>12</sup> Given that heart disease is the leading cause of death in our communities, claiming the lives of 50% to 60% of its victims before they reach hospital,<sup>13-15</sup> this phase of illness warrants greater medical interest and involvement.

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Table VI—Details of the 36 cases of drug overdose\*

Details	No. of patients
No. transported	
SPC	31
CA	5
Condition when ambulance arrived to transport patient†	
Unconscious	28
Respiratory arrest (endotracheal tube inserted in 8)	10
Circulatory collapse (systolic blood pressure 60 mm Hg or less)	6
Cardiac arrest	5
Outcome	
Dead on arrival at hospital	3
Died in hospital	7
Discharged alive	26

\*Mean age of the patients was 32.6 years.

†Ventilatory assistance was required by 14 patients.



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## Calcium infusion and pentagastrin injection in diagnosis of medullary thyroid carcinoma

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Calcium infusion and pentagastrin injection were compared as tests to stimulate calcitonin secretion for the detection of medullary carcinoma of the thyroid. Plasma concentrations of immunoreactive calcitonin were measured by radioimmunoassay before and during both stimulation tests in 2 persons who had been found at operation to have medullary thyroid carcinoma, 1 relative in whom a cervical lymph node biopsy had shown medullary thyroid carcinoma and 36 asymptomatic relatives.

The tests were carried out on separate days by intravenous infusion of calcium gluconate for 2 hours, to provide 3.75 mg/kg of elemental calcium per hour, and rapid intravenous injection of 0.5 µg/kg of pentagastrin. Before stimulation immunoreactive calcitonin was undetectable in the plasma of 34 of the 36 asymptomatic persons; the 2 with elevated baseline concentrations of the hormone had a positive response to both tests. Seven others showed an increase in plasma immunoreactive calcitonin concentration only after pentagastrin injection. The two persons with initially elevated values and three of the seven with increased values

after pentagastrin injection were found at subsequent operation to have focal medullary carcinoma and parafollicular cell hyperplasia; after the operation immunoreactive calcitonin was undetectable in the plasma, even after stimulation.

Rapid injection of pentagastrin is more reliable than slow infusion of calcium as a stimulation test for the early detection of medullary thyroid carcinoma.

La perfusion de calcium et l'injection de pentagastrine ont été comparées comme épreuves de stimulation de la sécrétion de calcitonine pour détecter le carcinome médullaire de la thyroïde. Les concentrations plasmatiques de calcitonine immunoréactive ont été mesurées par la méthode radioimmunologique avant et pendant chacun des deux tests de stimulation chez 2 personnes ayant présenté à l'opération un carcinome médullaire de la thyroïde, chez 1 parent dont la biopsie d'un ganglion cervical a révélé un carcinome médullaire thyroïdien et chez 36 parents asymptomatiques.

Les épreuves ont été menées à des jours différents par perfusion intraveineuse de gluconate de calcium pendant 2 heures, de façon à fournir 3.75 mg/kg de calcium élémentaire à l'heure, et l'injection intraveineuse rapide de 0.5 µg/kg de pentagastrine. Avant stimulation la calcitonine

immunoréactive n'a pu être décelée dans le plasma de 34 sujets asymptomatiques sur 36; les 2 sujets montrant une valeur initiale élevée de l'hormone ont eu des résultats positifs pour les deux épreuves. Sept autres personnes ont eu une augmentation de la concentration de calcitonine immunoréactive plasmatique après l'injection de pentagastrine seulement. Chez les deux personnes ayant des valeurs initiales élevées et chez trois des sept qui ont présenté une augmentation des valeurs après injection de pentagastrine on a retrouvé à la chirurgie un carcinome médullaire localisé et une hyperplasie des cellules parafolliculaires; après l'intervention la calcitonine immunoréactive n'a pu être détectée dans le plasma même après stimulation.

L'injection rapide de pentagastrine est plus exacte que la perfusion lente de calcium comme test de stimulation pour la détection précoce du carcinome médullaire de la thyroïde.

Medullary carcinoma of the thyroid<sup>1</sup> is a malignant tumour of thyroid parafollicular cells.<sup>2</sup> It may occur either sporadically or as a familial disease<sup>3-5</sup> inherited in an autosomal dominant pattern.<sup>6,7</sup> The association of familial medullary thyroid carcinoma with pheochromocytoma<sup>8</sup> or one of the multiple endocrine neoplasia type 2 syndromes<sup>7</sup> is well recognized. Med-

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